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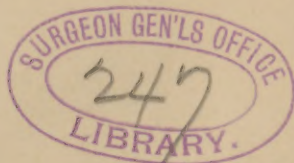
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BY



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ARTERIO-VEINous ANEURISM OF THE COMMON CAROTID ARTERY AND INTERNAL JUGULAR VEIN, WITH A CASE.

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PHILIP McM., 25 years old, a butcher by occupation, was admitted into Bellevue Hospital, in August, 1883, a rather small, but naturally muscular and robust man, with a markedly nervous and excitable temperament, and plainly showing the effects of prolonged indulgence in alcoholic drinks.

In February, 1882, he was stabbed in the neck on the left side with a penknife at a point now marked by a small scar half an inch behind the anterior margin of the sterno-cleido-mastoid, and on a level with the crico-thyroid space. Bleeding from the wound was profuse for about two hours, then ceased spontaneously, and the wound healed in a week without other treatment than that which he himself gave it. During this week the neck on the wounded side was much swollen, and there was at times much difficulty in breathing; the corresponding side of the face was œdematous. The swelling gradually diminished, and disappeared entirely, he thinks, in the course of two months.

Early in the following June, after a spree, a lump as large as a hen's egg formed at the seat of the wound, the cheek and neck again became swollen, and the difficulty in breathing recurred. He then consulted a physician, who called his attention particularly to a whirring sensation felt in the neck, which he had himself noticed for some time, but had thought nothing of. The lump and the other symptoms, except the thrill, disappeared, and in August he resumed work, but as the work caused the choking sensation, accompanied by dizziness, to return, he again abandoned it.

To what extent the injury enforced idleness, or whether it was not simply an acceptable excuse for self-indulgence, cannot now be determined, but it appears that since that time he has done no work, and has at times, perhaps persistently, been drinking heavily. He alleges discouragement as an excuse for his conduct, saying that during the year he consulted many physicians, became thoroughly acquainted (too much so, he thinks) with the nature of his injury, and was uniformly advised to seek no operation for its relief.

On admission to Bellevue Hospital, eighteen months after the infliction of the wound, he was tremulous and distinctly alcoholic, and complained

of nausea and gastric distress, of occasional choking, vertigo, some dimness of vision in the left eye, and dulness of hearing in the left ear. The last two symptoms were not confirmed by appropriate tests, and the first were thought to be due to alcoholism. The statements concerning the choking and vertigo probably shared the exaggeration that marked his account of other symptoms.

On the left side of his neck, in the position above described, is a non-adherent linear scar half an inch long. A very distinct thrill could be felt on the left antero-lateral region of the neck between the clavicle and the ear, with a loud buzzing sound strongly reinforced during the systole of the heart. The thrill was recognizable by the slightest touch, and could be arrested by firm pressure at the scar or on the line of the carotid below it. Pulsation was barely perceptible in the left facial artery, easily recognized in the left temporal artery, and was of the usual force in the corresponding arteries on the right side. No recognizable dilatation of the veins. Pupils equal and normally responsive. There seemed to be a slight deep swelling or thickening in front of the great vessels near the scar.

The symptoms and history clearly indicated the existence of a traumatic communication between a large artery and vein, and, together with the position of the scar, left no doubt in my mind that the artery was the common carotid, and the vein the internal jugular; and, as the vein overlies the artery completely on this side, I think the point of the knife must have passed completely through the vein, perforating it at two points, and punctured the adjoining wall of the artery. As there was no recognizable tumour, I inferred that there was no aneurismal sac intermediate between the vessels, but that their walls were in contact, and that the blood passed directly from the artery into the vein. The absence of recognizable dilatation of the veins and of symptoms indicating obstruction to the venous flow is to be explained by the ease with which the blood passes from the internal jugular to the heart, and perhaps also indicates that the opening in the artery was small. The history of a previous tumour and swelling indicates that the blood must at one time have escaped quite freely into the surrounding tissue.

After having kept the man under observation for more than a month, and having sought and received the counsel of several colleagues, I determined to operate. The controlling reasons for this decision were the man's alleged inability to work, about which some doubt might be felt, and his moral decadence, about which there was none. As to the first, he persisted in his assertions, after having been warned of their importance in determining the question of interference; and while it is probable that a man of stronger will and steadier nerves would, under similar circumstances, be able to regulate his life accordingly and earn a livelihood in spite of the infirmity, I think corroboration of this patient's sincerity is found in his persistent search for relief in the face of all the advice to the contrary which he had received.

As to the second reason, it may be claimed that his moral regeneration was a task belonging rather to the professional teacher of morals than to the surgeon, but it seemed to me that the latter might fairly deem himself under a professional obligation to remove an apparent obstacle that stood in the way. And while a successful result is by no means always a justification of the propriety of the interference which led to it, it carries the advantage of allowing that propriety to be called in question without exciting those painful regrets which arise from a consciousness of harm done through an error in judgment.

A decision as to the details of the operation was also reached with some difficulty, partly because of doubt as to the extent to which the tissues about the seat of injury had undergone change. The point of communication between the two vessels appeared to be not more than three-fourths of an inch below the bifurcation of the artery, and perhaps not more than half an inch, and therefore the application of a ligature to the common trunk on the distal side of the opening, in addition to the necessary one on the proximal side, seemed too hazardous to be undertaken. The alternative of placing the second ligature upon the internal carotid, with or without a third upon the external carotid, was also rejected, and I determined to tie the artery at one point only, and that as near to the opening on the proximal side as possible, hoping either that the distal clot would extend far enough to close the opening, or that the reverse current through the internal and external carotid would prove too slight to cause inconvenience.

The operation was done October 8th. The vessel was approached above the omo-hyoid, but as the tissues immediately overlying it were found thickened and condensed, the incision was extended downward, and the artery tied below the muscle. It was necessary to divide one of the inferior thyroid veins between two ligatures in order to expose the artery. The ligature was of stout catgut (E violin string), prepared by soaking in oil of juniper and keeping in alcohol. The wound was frequently irrigated during the operation with a solution of salicylic and boracic acid, 1 and 6 parts respectively in 500 of water, and at the last was washed with carbolic acid, 1 in 20. A rather short drainage tube was inserted, and the incision closed with catgut sutures. Carbolyzed gauze dressings were applied so as to fill the normal depressions and make snug pressure.

The left side of the face was cool and pale during the afternoon, but had recovered its colour and temperature the next morning, and except for some nausea the man was then comfortable and his condition natural.

During the first six days the temperature did not rise above $99\frac{3}{4}^{\circ}$. The dressing was changed for the first time on the 14th day, and the wound was then found perfectly dry and healed throughout, even over the drainage-tube which had slipped in. Two stitches were cut, and the edges of the wound separated for about an inch to remove the tube. On the 7th day, the temperature rose in the afternoon to $102\frac{1}{4}^{\circ}$, fell the next morning to $98\frac{1}{2}^{\circ}$, and after rising again the following afternoon to $100\frac{1}{4}^{\circ}$ remained below 99° . Oct. 17th there remained only a small dry scab at the seat of the drainage tube, and the dressing was discontinued.

The thrill ceased entirely when the ligature was tied, but at the first change of dressing, on the 4th day, it was again present, though with greatly diminished force and recognizable only on deep pressure with the finger over a small area about the opening; it increased somewhat in area and force during the next few days. On the evening of the 10th day the patient was awakened by an attack of dyspnoea with precordial distress and pain, and was much frightened; he received some morphine subcutaneously, soon went quietly to sleep, and awoke the next day free from all the unpleasant symptoms. I suspected the cause of this attack to be a pulmonary embolus, either a portion of the distal arterial clot broken off and washed through the opening into the vein, or a portion formed in the vein by growth through the opening. But as the patient was quite hysterical during the following fortnight, and made frequent complaint of pain behind the lower part of the sternum and in the epigastrium, the diagnosis remains in doubt. There can be little doubt about a second accident which occurred on the 15th day, when he noticed in the morning a little dizziness and a slight loss of power in the right hand; the pupils were equal and normal, and there were no other paralyses. The symptoms, which were probably due to a small cerebral embolus, disappeared within an hour or two, and have not recurred.

The thrill is now, seven weeks after the operation, recognizable only over the seat of the opening, and can be arrested by moderately firm pressure at that point, or by deep pressure behind the angle of the jaw; it is steady and continuous. The portion of the anterior temporal artery visible on the side of the forehead is notably enlarged, and pulsates strongly; its pulsation is arrested by distal pressure.

I have found nine similar cases recorded or mentioned, together with three of traumatic communication between the internal carotid and internal jugular, and six between the external carotid and a vein in the neck.

I. COMMON CAROTID AND INTERNAL JUGULAR.

1. Reported by Marx in *Mém de l'Acad. de Méd.*, 1833, vol. iii. p. 233. A man forty-three years old who, twenty years before, had received in a duel a sabre-wound in the right side of the neck just above the inner end of the clavicle. The wound was half an inch long, and bled profusely; he arrested the bleeding by pressure with his handkerchief, and went alone and on foot to the hospital, a distance of two miles. In five days the wound was healed, and he left the hospital. He suffered no further inconvenience from it. At the time of the report, twenty years later, there was still a thrill with peculiar bruit, arrested by pressure on the line of the carotid $1\frac{1}{2}$ inches above the scar.

2. Mentioned briefly by Lefort in *Diet. Encyclopédique*, Art. Carotide, p. 644. A soldier received a sabre-cut in a duel; the bleeding was arrested by pressure. A large tumour formed with a peculiar thrill perceptible between the clavicle and ear, and with a bellows-murmur. He left the hospital on the 45th day, the tumour having shrunk to the size of a small nut. The scantiness of the details leaves some doubt as to the exact nature of this injury.

3. Larrey, *Clinique Chirurg.*, vol. iii., 1829, p. 149. A soldier, forty-one years old, received a sabre-cut on the right side of the neck just above the sterno-clavicular joint. The hemorrhage was so free that it placed the man's life in immediate peril; it was arrested by bandaging, and the patient was brought to the hospital. There was a large tumour under the wound, and pulsation in, and dilatation of, the external jugular vein; thrill. The wound was half an inch long, and divided the inner portion of the sterno-cleido-mastoid muscle. The tumour disappeared entirely about the 60th day; the thrill and bruit persisted. The man returned to duty. Larrey thought the artery was wounded near its origin, and that both sides of the vein were perforated.

4. Larrey, *loc. cit.*, p. 154. A soldier, thirty-seven years old, was wounded in the lower right side of the neck while fencing with a comrade. The wound was small, and the bleeding slight; there was an ovoid aneurismal tumour under the wound with thrill and bruit. Dismissed cured in two months, the thrill persisting. Both these cases were treated by the continuous application of ice.

5. *Allgemeine med. Zeitung*, April, 1833; abstract in *Arch. Gén. de Méd.*, 1834, 2d ser. vol. iv. p. 135. A student was wounded in a duel in March, 1833, the narrow blade of the sword penetrating to a distance of three inches downwards and inwards; the external wound was one inch below (?) the middle of the right clavicle, or a little nearer its sternal end. Only a few drops of blood escaped. A large tumour immediately formed above the clavicle; the patient fainted, and had tetanic convulsions and dyspnoea, which were relieved by free venesection. The next day the tumour pulsated with "a peculiar sound like that of a liquid escaping through a narrow orifice;" three weeks later the tumour was reduced to the size of a hen's egg, pulsation and bruit persisting. Eight months afterwards the bruit could be heard only over the point of communication between the vessels, and the tumour could be entirely reduced by a full inspiration. The patient considered himself entirely well, and was leading a very gay life.

6. *Pennsylvania Hosp. Reports*, vol. i. p. 195, and Norris in *Amer. Journ. Med. Sci.*, 1847, vol. xl. p. 13. A coloured seaman, 59 years old, admitted April, 1836, with a "traumatic varicose aneurism" on the right side, for which the carotid was tied by Randolph a month later. He died, comatose, the next day. (The record on the Hospital books, for a copy of which I am indebted to the kindness of Mr. Cadbury, the steward, is even more brief, and speaks of it as "aneurism of the carotid.")

7. Dr. David Prince, *U. S. Sanitary Com. Surg. Mem.*, vol. i. p. 147. Soldier; 20 years old; pistol shot in left side of neck, one inch from median line at the level of the larynx; not much bleeding. Eighth day, swelling less, very distinct thrill, perceptible to touch, and loud whizzing murmur heard through stethoscope; slight bleeding occurred in the evening. Ninth day, common carotid tied; patient remained stupid and drowsy most of the time for nearly five days, and then died. On the third day symptoms of partial paralysis of sensation and motions in the right extremities were observed, and twelve hours before death "a sweat came upon the right half of the body and *not* upon the left." The autopsy showed that the bullet had notched the artery on its outer side at the bifurcation, and had perforated the internal jugular vein. There was no distinct aneurismal sac, no clot in the distal portion of the carotid. The corpus callosum and optic thalamus seemed softer on the left than on the right side. "Nothing abnormal was found elsewhere."

8. Verneuil, *Bull. de la Soc. de Chirurgie*, second series, 1870, vol. x. p. 487. A man, 40 years old, received a pistol-shot wound in the right side of the neck, two centimeters below the bifurcation of the carotid, and midway the width of the sterno-cleido-mastoid. Bleeding was slight. The next day the neck was slightly and uniformly swollen, with intense thrill and very loud double bellows murmur or spinning-wheel sound, perceptible over an area two inches wide, and extending from the mastoid process to the clavicle, but with their maximum at the seat of the wound. Pulsation equal in the temporal arteries; continuous application of ice. On the ninth day the wound was almost entirely healed, the swelling had subsided; the thrill and murmur persisted with the same intensity, but had not been noticed by the patient.

9. Maclean,¹ in *Perrin's Journ. of Med.*, Detroit, 1875, xi. p. 261. "Pistol-shot wound from above, penetrating neck on left side. Healed. Distinct buzzing sound continued over seat of wound. Health good. No aneurismal sac at seat of injury. Arterial pulsation synchronous with beat of heart. Diagnosis: Arterio-venous aneurism of common carotid and internal jugular, or one of the inferior thyroid veins."

10. The one above reported.

¹ For this abstract and four of the following (Mazzoni, Queirel, Duval, and Desparanches) I am indebted to the kindness of Dr. J. S. Billings, of the Library of the Surgeon-General's Office, Washington.

To this series may be added a case, apparently unique, of supposed non-traumatic communication between the common carotid and the internal jugular, reported in the *London Med. Gazette*, 1842, vol. xxxi. p. 107.

A woman, 66 years old, with a large, pulsating tumour on the right side of the neck, extending from left sterno-clavicular joint to middle of right clavicle, and up to the right ear. The body of the tumour is firm and somewhat lobulated. There is a projecting portion as large as a hen's egg near the ear, which is "soft, movable, easily emptied, and has a strong vibratory motion. To the outside of this projection the integuments have a very distinct vibratory motion, as if a small bird or insect were fluttering strongly under them. . . . Pulsation and bellows murmur throughout the whole tumour, but over the projection and portion of integument just alluded to the sound is very loud, whizzing, and like that of an old-fashioned spinning-wheel." The carotid artery and a very large vein, thought to be the internal jugular, could be distinctly traced along the upper half of the outer side of the tumour. Pressure on the side of the tumour or on this vein arrested or diminished the thrill and sound. The patient said the tumour had begun thirty years before at the lower part of the neck, and had gradually enlarged. The soft portion appeared six years before this examination, after vomiting and coughing. [Nine years afterwards the patient was alive and the tumour unchanged.]

II. INTERNAL CAROTID AND JUGULAR VEIN.

1. Duval, *Arch. de Méd. Nav.*, Paris, 1864, i. p. 413. "Stab-wound behind left ear. Frightful hemorrhage; general tumefaction with thrill and indistinct sounds. Under treatment, tumour diminished and wound healed completely. Diagnosis: Arterio-venous aneurism of the internal carotid and jugular. A year later the wound reopened, hemorrhage returned, characteristic sound slowly diminished."

2. Joret, *Gaz. Méd. de Paris*, 1840, 2d ser., vol. viii. p. 457. A man, 35 years old, wounded in a duel, the ball entering on the right side of the face, traversing the nostrils and upper part of the pharynx, and penetrating again behind the left tonsil. Free hemorrhage. The patient was apparently well after a month, with the exception of much headache and strabismus. Four months after the injury an attack of aphasia, from which he recovered; during the following two years his mind weakened, he had epileptiform attacks, and died about thirty months after the injury. The ball was found lodged in the left internal jugular behind the angle of the jaw. At the upper portion of the internal carotid was an aneurism as large as a pigeon's egg, communicating also with the internal jugular. The portion of this vein between the ball and the heart was normal; the wall of its distal portion was so thickened that it could hardly be distinguished from the artery. Two foci of softening in the brain, and two small cerebral veins distended to form pouches one-third of an inch in diameter, and filled with clots.

During the latter part of the patient's life there was a pulsating swelling behind the ramus of the left jaw, with the "murmur pathognomonic of varicose aneurism;" there was also projection of the left eye.

3. Giralde, *Bull. de la Soc. Anat.*, 1854, vol. xxix. p. 298. A man, wounded by a single bird-shot in the right side of the neck, just below the angle of the jaw. This was immediately followed by diffuse swelling of the right side of the neck, with characteristic thrill and double murmur. A month after the accident the swelling and ecchymosis had disappeared, leaving a small pulsating tumour. An operation was proposed and declined, and the patient left the hospital. He returned shortly afterwards with malignant anthrax, and died.

The autopsy showed an aneurismal sac as large as the end of the little finger, lying between and communicating with the internal carotid and jugular, and containing the small shot. The opening into the carotid was a short distance above the bifurcation, and was as large as a crow's quill; the opening into the vein was a little smaller.

III. EXTERNAL CAROTID AND EXTERNAL JUGULAR.

In some of the following cases doubt must be felt as to the identity of the vessels involved.

1 Desparanches, *Journ. Gén. de Méd. Chir. et Pharm.*, Paris, 1819, vol. lxvii. p. 202. "Stab in neck. Arterio-venous aneurism of left external carotid and jugular vein. Usual sound as above described. Slight symptoms of paralysis of the corresponding arm. Eight months later man seen in same condition.

2. Queirel, *Mars. Méd.*, 1872, vol. ix. p. 354. "Sailor, 40 years of age, large tumour over external jugular vein, slightly pulsating. Auscultation *souffle à double courant*. No serious inconvenience."

3. Holston, *Western Lancet*, April, 1856, p. 199. The patient was a man 50 years old, who, fifteen or twenty years before, had received a charge of bird-shot in his neck, followed by the formation of a small pulsating tumour which caused no trouble except "throbbing, which extended to his brain, and often confused his mind." Within two years the tumour had become much larger. "The vein [which ?] also increased in size, and the thrilling sensation extended downward to the breast, as well as upward to the head. The eye on that side [apparently the right side] inflamed, and its sight became impaired, the hearing was also nearly lost on that side. Memory was much weakened, and he laboured under constant and considerable confusion of mind." The aneurismal tumour was on a level with the larynx, as large as a hulled walnut, and pulsated; the facial vein formed a bunch as large as an egg at the angle of the jaw; the external jugular was tortuous and as thick as the forefinger. The carotid was tied below the omo-hyoid; the patient was comatose the next morning, and died fifty-five hours after operation.

4. Mazzoni, *Clin. Chir.*, Rome, 1876, iii. p. 138. "Woman, 24 years of age. A month previous had received a cut in the neck; wound slight; healed rapidly. A continued bellows-sound producing great discomfort brought her to the clinic. Cicatrix three centimeters long. Placing hand on tumour a thrill and pulsation corresponding to beat of heart was observed, with loud bellows-sound. On pressure of carotid pulsation in tumour ceased. Diagnosis: Arterio-venous aneurism of external carotid and jugular. Compression made constantly three days and nights unsuccessfully. Tumour was laid bare, and common carotid tied. On tenth day after operation hemorrhage commenced, and continued during two or three days; it was thought to come from the superior thyroid, which was tied. Transfusion of blood. Died on twelfth day, exsanguinated."

5. Ruz, *Bull. de l'Acad. de Méd.*, Paris, 1838-9, vol. iii. p. 278. A man, 38 years old, who, fourteen years before, had been struck on the left side of the head with a bottle; a fine linear cicatrix in front of the ear. Several tumours, evidently formed by the dilatation of veins, occupy the left side of the cheek and head; the largest and lowest extends from the tragus to the angle of the jaw, and forward to the anterior border of the masseter; they are soft, subcutaneous, evidently filled with liquid; the overlying skin shows no change in colour, but is much distended. An aneurismal thrill is easily recognized, by ear and finger, in each tumour, and is most marked in the largest. Pressure on the carotid arrests the thrill and the tumours shrink. The left eye is prominent, and the veins of its conjunctiva varicose.

6. Parkman, *Am. Journ. Med. Sci.*, April, 1853, p. 370. A man, 35 years of age, who, at the age of 11, was struck within the right ear with a small chisel. Profuse bleeding. The external jugular vein is enlarged throughout its whole length to diameter of two inches; some slight enlargement of the veins of the temple. In front of the ear there is very strong pulsation with loud, purring thrill. There had been no change in the condition for many years, and the patient did not desire treatment.

Of the nineteen patients, eighteen were males, one a woman; a disproportion which is readily explained by the traumatic character of the cause. In ten cases the cause was a stab-wound (five with a sword, four

with a knife, one with a small chisel), in four a pistol-shot wound, in two a wound by bird-shot, in one a blow with a bottle, in two unknown.

Excluding for the moment from consideration those cases in which the external jugular vein or its immediate branches were directly involved, the attention is arrested by the absence of those changes which are so prominent a feature when a similar communication between an artery and a vein occurs in other regions of the body, and which cause so much discomfort and even disability. These changes, as is well known, are a marked and often irregular dilatation of the veins, not only near the point of communication, but also in the distant branches on the distal side, interference with the distal flow, and the usual formation of an aneurismal sac with the usual tendency to increase in size.

The cause of these changes is the increase of the pressure within the veins, produced by the passage into them of the arterial blood. Normally the pressure of the blood in the distal veins of the extremities is slight, seldom exceeding that of a column of mercury half an inch high, and the venous flow in them is carried on by a *vis a tergo* communicated through the capillaries, aided by such other influences as the pressure of the contracting muscles, the changing position of the limbs, and the suction exerted by the thorax during inspiration. The numerous valves placed along the course of the veins preserve each advance as it is gained, and protect the underlying branches from the extension to them of accidental temporary increase of pressure in the trunks above.

When arterial blood passes directly from an artery into a corresponding vein, it does so under a pressure that is far in excess of that previously existing in the vein; it cannot escape toward the heart without lifting and rapidly pushing before it the venous column on the proximal side, without, in other words, exerting a pressure much in excess of the normal venous pressure, and this pressure must of course be equally exerted in an opposite, distal, direction, and laterally upon the wall of the vein. Under this increased pressure the wall yields, and the lumen of the vein enlarges; so long as the distal valves remain sufficient this pressure is not transmitted to the veins beyond them, but the passage of the blood through the latter is obstructed by the obstacle thus placed before it; when, however, the valves yield under the pressure or become insufficient by the enlargement of the vein, the pressure is transmitted from above to the segments thus deprived of protection, and the same changes occur in turn in them. The extent of the change depends upon the size of the opening in the artery and the relative amount of the blood which escapes from it; when that opening is large, as, for example, when the artery is cut completely across, all or nearly all of the arterial blood makes its way into the vein, and may even reverse the current in the distal segment of the latter, and make its way back to the heart with difficulty through the branches and their anastomoses.

The essential cause, therefore, of the changes which make the injury so serious is the pressure of confined blood within organs incapable of resisting it, the tension of a quantity of blood which is pressed upon strongly from behind by the arterial column, and escapes with difficulty through the vein. The amount of pressure varies directly with the insufficiency of the means of escape, and the changes in the walls of the veins vary with this pressure.

But when the communication is between the common carotid and the internal jugular, the conditions are very different. Here the venous current is habitually aided, not opposed, by gravity, and instead of being pushed forward by a *vis a tergo* it is drawn along by a *vis a fronte*, the strong suction of the chest during each inspiration, and the feebleness of the elastic return of the lung upon itself during expiration. Instead of being distended the wall of the vein is habitually flaccid, and the pressure within it is *nil* or even negative. In addition, its lumen is very large and it communicates within a short distance with other trunks as large and even larger than itself, in which also the pressure is negative and into which, therefore, any temporary excess of blood will readily escape.

If the opening from one vessel into the other is not direct, if, in other words, there is an intermediate aneurismal sac, this sac is not large and does not grow larger as a similar one does which communicates with an artery alone. In the latter case the sac pulsates and enlarges because the pressure in it corresponds to that within the artery, rising and falling with it through a range on either side of the mean arterial pressure; and the constant action of this pressure gradually distends the wall of the sac.

But when the sac communicates also with the vein, the average pressure is less, and the same maximum is never reached, because the incoming blood is no longer confined, but escapes into the vein as readily as it enters from the artery, and is thus prevented from exerting a distending pressure upon the wall of the sac. The change, therefore, when once fairly established has no tendency to increase.

When, however, the external jugular vein is directly involved the conditions more nearly resemble those found in other parts of the body. The escape of the blood through the vein to the heart is not entirely free, and hence the distal flow is obstructed. The effects of this obstruction are shown very clearly in Ruz's case (III. 5), where a series of tumours decreasing in size from below upward formed along the veins of the cheek, forehead, and scalp, tumours formed by dilatation of the veins. In the other cases of the same group the aneurismal tumour was large, or the external jugular notably dilated. In two of them, Holston's and Mazzoni's, the discomforts thus produced were so great that an operation was undertaken.

In one of the three cases in which the internal carotid was the artery injured (Joret's, II. 2), in which the opening was above the angle of the

jaw, and in which the flow through the internal jugular was obstructed by a pistol-ball lodged in the vein on the proximal side of the opening, changes due to the obstruction took place in the veins within the cranium, and death followed two years after the injury in consequence of these changes and apparently also of cerebral emboli originating in the associated aneurismal sac. The presence of an aneurismal sac in this case supports the explanation above given of its absence in the others, because in this one the conservative condition of free venous flow toward the heart did not exist.

Another feature of much interest is the facility with which hemorrhage was arrested and the external wound healed. In the absence of other statistics showing how frequently men have perished by primary hemorrhage after a wound of both these vessels, it would be improper to infer that recovery is the rule or even frequent. It is well known, however, that death by hemorrhage is common after wound of the artery alone, and it may, I think, be plausibly maintained that the additional wound of the vein is a favourable condition, and diminishes the risks arising from the wound of the artery. And this, for the same reason that makes the later changes less serious, the free escape of the effused blood into the vein and thence back to the heart. When the artery alone is wounded, the blood, if its immediate escape through the external wound is prevented by the shifting of the latter's walls or by dressings, infiltrates and presses back the surrounding tissues until it forms a collection the tension of which is approximately equal to that of the blood within the artery; and under the influence of this tension, the external wound reopens and the hemorrhage recurs. When, on the other hand, there is also an opening into the vein, the effused blood is drawn into it by the thoracic suction and forced in by its own pressure, and thus the collection is kept small and its tension too low to force the edges of the external wound apart. At each beat of the heart as much blood comes from the artery as if it alone were divided, but the patient does not lose it, it is simply turned back again to the heart; a portion of the stream is withdrawn for a moment from the vessels and then returned to them, *auto-refusion*. And as regards the distal circulation in the corresponding territory there is no more change than, indeed not so much as, if a ligature had been placed upon the artery.

The course of the affection in the principal group of cases, after it had become established, was eminently benign; that in the group in which the external jugular was involved less so, and it was complicated also by the presence of venous tumours immediately under the skin which threatened by their liability to injury.

Of the ten cases of the common carotid and the three of the internal carotid, one (Joret's) died two years after the injury, and apparently of cerebral lesions arising from it; one (Prince's) was operated upon on the ninth day, and died of the operation; one (Giraldes's) died of an intercur-

rent disease shortly after recovery from the wound; of one (Randolph's) no details are known, except that an operation was considered necessary, and he died in consequence. The others, nine in number, recovered easily from the injury, and, with the single exception of mine, appear to have suffered no inconvenience from the persisting lesion; the history of one of them covers a period of twenty years subsequent to the injury, that of the others varying periods counted only by months.

Of the six cases in which the external jugular vein was involved, in one (Desparanches's) details are lacking; in another (Mazzoni's) so much discomfort was caused by the throbbing that the patient sought relief by operation one month after the injury, and died. In one (Holston's) occasional mental confusion was caused during fifteen or twenty years, then the tumour grew larger and the symptoms more marked; relief by operation was sought, and the patient died. In two (Rutz's and Parkman's), covering periods of fourteen and twenty-four years respectively, the patients suffered no inconvenience, and declined operation. In the remaining one (Queirel's) there was "no serious inconvenience."

The mortality, four deaths in five operations, is vastly in excess of that of the same operation, ligature of the common carotid, under other circumstances. One of the deaths was due to a cause, secondary hemorrhage, which is always liable to occur, and which excites no comment except upon its rarity. The causes in the other cases are obscure or unknown; one of the patients died within twenty-four hours after the operation, another in fifty-five hours, the third on the fifth day. Concerning the first there are no details except that the patient died comatose, and Norris, in his table of operations upon the arteries prepared more than ten years afterwards, gives "congestion of the brain" as the cause. The second patient (Holston's) became comatose during the night following the operation, and remained so until death, partial hemiplegia on the opposite side occurring meanwhile. In the third case (Prince's) the patient remained stupid and drowsy until death on the fifth day, and in him also symptoms of paralysis on the opposite side promptly appeared; the patient was operated upon on the ninth day after the receipt of the injury, no clot was found in the distal portion of the artery, and the surgeon attributed death to acute anemia of the brain. Concerning the previous history of the first of these three nothing is known; the second, after many years of comparative immunity, presented before the operation cerebral symptoms which may have had another cause, and which were rapidly increasing in severity. There is a free field for speculation as to the probable periods of survival if the operations had not been done, but it cannot be doubted that the operations were the immediate cause of death.

No other treatment seems to have been employed in any case except Mazzoni's, in which compression was tried for three days before resort

was had to operation. In my case the patient could hardly bear momentary pressure sufficiently firm to arrest the thrill.

Finally, if a case should again arise in which an operation might be deemed necessary, what should the operation be? The experience gained in operations for the relief of arterio-venous aneurisms in other parts of the body cannot be wholly relied upon to guide us in a choice, because of the differences in the conditions present and in the objects to be attained.

The anatomical conditions peremptorily exclude all those operative methods in which the sac is opened; and equally of course no one would think of tying both the artery and vein above and below the point of communication. There remains, then, only ligation of the artery on one or on both sides of the opening. (In *recent* cases pressure, if it could be borne, and if the proximity of the pneumogastric nerve did not prevent, might work a cure as it has done elsewhere.)

A guide in making the choice is to be found in the object to be attained. This object is not, as it is so frequently elsewhere, to secure the obliteration of an aneurismal sac which disables by its size and threatens by its steady growth, and into which it is unwise to allow any arterial blood to continue to enter, but it is merely to diminish the amount of the blood which escapes from the artery, to reduce it to that which can be readily carried away by the vein. This is an end with which the surgeon may well be content, even while recognizing that there is a superior one; for while it falls short of completeness, its shortcoming will probably cause no disability, no weakness, its lack of perfection does not make itself obtrusively manifest, and, if need be, the second step that leads to a complete shutting off of the stream can be subsequently taken without additional difficulty or danger.

Judged by the standard so neatly formulated by Verneuil, "*l'efficacité, la b nignit , la facilit *," proximal ligation of the artery seems to deserve the choice. It may be less efficacious, but it is also less dangerous and easier of execution than double ligation, and it offers the chance not only of reducing the evil to a degree at which it can be well borne, but even of curing it entirely by the growth of the distal clot within the artery. This clot may be fairly expected to extend to the opening, which takes the place of the first collateral branch so much insisted upon in operations upon vessels, and it is quite within the range of possibility that it should overlap or plug it.

A second ligature upon the distal side of the common trunk, or upon the internal carotid if there should not be sufficient room upon the other, doubles some of the risks by doubling the operation, and increases the probability of the occurrence of cerebral embolism or of a thrombus extending into the cerebral arteries. On the other hand, it is to be said in its favour that by preventing a recurrent stream through the internal caro-

tid it prevents the withdrawal, before distribution, of a portion of the blood carried to the brain by the arteries of the other side, and thus diminishes the chance of the occurrence of dangerous acute cerebral anæmia. This chance must exist, though to a less degree, in all ligations of the common carotid, the blood passing down the internal to be distributed through the external carotid; but, judged at least by the operations of the last ten or fifteen years, it is not a very serious one, and it might be made still less by pressure on the internal carotid for a few hours after the operation.

When the communication is between the external carotid or one of its branches and the external jugular the conditions are less simple, and so varied that the choice of an operation must vary with them. These cases have more in common with arterio-venous aneurism of the extremities, and the general principles of treatment are more nearly the same. So far as they can be formulated for the latter, they suggest the ligation of all vessels entering or leaving the sac so far as this can be done without opening it, but such a plan should certainly not be carried out in its entirety if the external jugular is dilated throughout its course to the extent noted in some of the cases here mentioned. As the diameter of the external carotid artery is comparatively small, it is more likely that the vessel will be completely divided in the original injury, and this is still more true of its branches; and the well-established tendency of the distal portion to become occluded under such circumstances would, I think, justify the surgeon in limiting his operation to the placing of a single ligature on the proximal side, and of course on the wounded artery, if practicable, rather than on the common carotid. The number, size, and free anastomosis of the veins of the region are such that an attempt to secure all the afferent ones would be bloody, dangerous, and probably unsuccessful.

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
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